masses and mutual distances. After proving that any number of spheres may move so that the central force shall vary directly as the distance, he shows that only certain values of φ are possible for an infinite number of spheres, giving the criterion of possibility; and thence that the only possible law of central force for an infinite number of spheres is that in which the force varies directly as the distance.

The author then enters upon some general considerations on the physical impossibility of an universal law, rigorously exact and expressed by equations involving differentials of no higher order than the second, and on the amount of disturbance by extraneous agencies. Having shown how all equations expressed by rectangular coordinates may be transformed into others involving only the mutual distances of the spheres at m equal intervals of time, he gives an equation of differences defining the motion of n points, such that the distances and their differentials of every order not exceeding m may have any assigned values.

After deducing a general formula for transforming equations of differences not exceeding the mth order into equations between the distances at m equal intervals of time, the author applies it to the last equation, and shows that the equations so found are possible for any number of moving points and for every value of m; and that the most general law, by which the motion of n equal spheres can be determined, so that all move according to the same law at all times, may be found by taking a proper value of m. He then shows that these equations give a method of unlimited approximation to any unknown law; and suggests the mode of extending the solution of the problem to solids of any figure and mass. Finally, he gives the mth differential of the distance between any pair of points moving according to this law, in terms of the differentials of lower orders including the distances.

June 21, 1849.

The EARL OF ROSSE, President, in the Chair.

The following Gentlemen were admitted into the Society:—

Sir Robert Kane, M.D.; Thomas Andrews, M.D.; John Scott Russell, Esq.

The Right Rev. The Lord Bishop of Manchester was elected into the Society.

The following papers were read:—

1. "On the Anatomy and Affinities of the Family of Medusæ." By Henry Huxley, Esq. Communicated by the Bishop of Norwich, F.R.S.

The author commences by remarking that no class of animals has been so much investigated with so little satisfactory and comprehensive result as the family of *Medusæ* (including under that name the *Medusæ*, *Monostomatæ* and the *Rhizostomidæ*), and proposes in this

paper to give a connected view of the whole class considered as organized upon a given type, and an inquiry into its relations with other families. This he has been enabled to do through numerous and peculiar opportunities for the investigation of these animals, enjoyed during a cruise of some months along the eastern coast of Australia and in Bass's Strait*.

The memoir is divided into two sections, of which the first treats of the anatomy of the Medusæ, and the second of their affinities.

The organs of the Medusæ are formed out of two distinct membranes—foundation membranes. Both are cellular, but the inner is in general softer, less transparent and more richly ciliated than the outer, but contains fewer thread-cells. The outer is dense, transparent, and either distinctly cellular or developed into a muscular membrane. It may be ciliated or not, and is usually thickly beset with thread-cells, either scattered through its substance or concentrated upon more or less raised papillæ developed from its surface. When the stomach is attached to the disc, the outer membrane passes into the general substance of the disc, while the inner becomes continuous with the lining membrane of the canals. There is a larger or smaller space, termed by the author the "common cavity," between the inner aperture of the stomach and the openings of the canals, with which both communicate. This is the structure of the stomach in the Cryptocarpæ and Phanerocarpæ; in the Rhizostomidæ it is fundamentally the same, but the stomachs are very minute, and collected on the edges and extremities of the ramuscules, a common stem. The Rhizostomes, *quoad* their digestive system, have the same relation to the Monostome Medusæ that the Sertularian Polypes have to the Hydræ, or the Coralline Polypes to the Actiniæ. In consequence of a very irritable contractile membrane surrounding and overlapping the orifices of their stomachs, they are seen with difficulty. This membrane consists of two processes, one from each side of the perforated edge of the branch. In *Rhizostoma* they generally remain distinct, but in *Cephea* they are frequently united in front of and behind each aperture so as to form a distinct polype-like cell. In the structure of the disc there exists no difference between the Monostome and Rhizostome Medusæ. The author gives an account of his observations on the minute structure of the disc. The arrangement of the cavities and canals of the disc differs in the different sections. In very many of the Cryptocarpæ there is a circular, valvate, muscular membrane developed from the inner and under edge of the disc. In the Phanerocarpæ such a membrane does not seem to be present, but in *Rhizostoma* and *Cephea* it is evidently replaced by the inflexed edge of the disc. In the Cryptocarpæ the marginal corpuscles are sessile upon the circular vessel. They are spheroidal vesicles, containing a clear fluid, and one or more strongly-refracting bodies occasionally included within a delicate cell. The marginal vesicles are placed between

* Mr. Huxley is Assistant-Surgeon to H.M.S. Rattlesnake, now engaged on a surveying voyage conducted by Capt. Stanley on the coasts of Australia and New Guinea.

the inner and outer membranes of the circular vessel. In the Phanerocarpæ the marginal corpuscles are pedunculated and protected by a semilunar fold. The author describes peculiarities in this part of the organization of *Rhizostoma*. The excretory orifices, described by Ehrenberg as general in *Medusa aurita*, were not detected by the author in *Cephea ocellata*. Nor does he admit the supposed nerves and intertentacular ganglia of that author to be such.

Paragraphs 29 to 36 are occupied by a minute description of the tentacles of Medusæ.

The generative organs of the three groups of Medusæ are always portions more or less developed of the walls of the system of canals, and consist of the two "foundation" membranes, in or between which the generative elements, whether ova or spermatozoa, are developed. This the author concludes from his observations on several genera, which he gives in detail, and which add considerably to, and differ in some respects materially from, what has been stated by previous observers. In the ovarium, the two membranes develope between them immense multitudes of ova with a dark granulous yelk and clear germinal vesicle. The ova are attached to the outer surface of the inner membrane. In the testis the inner membrane is produced into a vast number of thick pyriform sacs, which lie between the two membranes, with their blind ends towards the inner surface of the outer membrane; internally, they open each by a distinct aperture on the fine surface of the inner membrane. The contents of the sacs are spermatozoa, and cells in every stage of development towards spermatozoa, which appear to be formed by the elongation of the secondary cells contained in the large cells.

The author's observations lead him to believe that the muscular fibres are always developed in the outer "foundation" membrane. Each fibre in *Rhizostoma* is made up of very small and indistinct fibrils, which are transversely striated. He has not observed any indubitable trace of a nervous system in the Medusæ, nor of the so-called blood-vascular system described by Will.

In this section of the memoir the affinities of the Medusæ are considered. In their essential characters,—viz. their construction out of two membranes inclosing a variously-shaped cavity; their generative organs being external and variously developed processes of the two membranes; and the universal presence of the peculiar organs called thread-cells,—they present a striking resemblance to other families of Zoophytes, as the Hydroid and Sertularian Polypes, the Physophoridæ and the Diphydæ The disc of a *Medusa* is represented by the natatorial organ among the Diphydæ and Physophoridæ, but has no homologue among the Hydræ and Sertulariæ. The cell of the Sertularian Polype rather resembles the "bract" of the Diphydæ than the natatorial organ, and the latter family forms a connecting link between the Medusæ and the Physophoridæ. Of the two kinds of tentacles in the Medusæ, the first is represented in the Physophoridæ and Diphydæ, by the thickenings, richly beset with thread-cells, that frequently occur in the lip of the stomach; in the Sertularian Polypes by the tentacles of the margin

of the mouth. The second kind is homologous with the prehensile organs of the Diphydæ and Physophoridæ, and with the peculiar clavate processes of *Plumularia*. All these organs commence their development as bud-like processes of the two joining membranes. The peculiar clavate organs of *Plumularia* are developed from the common tube independently of the stomach. They have not been hitherto described, and were observed by the author in two species of *Plumularia* dredged at Port Curtis. They were of two kinds, the one attached to the cell of the polype, the other to the pedicle of the ovary. To each species there were three processes of the former kind, two above proceeding from near that edge of the aperture which is towards the stem, the other below from the front part of the base of the cell. They were conical in one species, club-shaped and articulated in the other, and consisted of an external horny membrane open at the apex, and an internal delicate membrane inclosing a cavity, all these being continuous with the corresponding parts of the stem. At the apex of each, and capable of being pressed through the aperture, lay a number of thread-cells. The second kind of organ was present in the species with conical processes. It consisted of a stem proceeding from the pedicle of the ovary, bearing a series of conical bodies, having the same constitution as those just described; the whole bearing a close resemblance to the prehensile organs of the Diphydæ.

The following table exhibits the homologies of the several families, which must be regarded as by no means so distinct as hitherto supposed, but rather as members of one great group, organized upon one simple and uniform plan, and even in their most complex and aberrant forms reducible to the same type.

Stomachs identical in Structure throughout.

	Medusæ.	*Physophoridæ.*	*Diphydæ.*	*Sertularidæ.*	*Hydræ.*
Disc	Natatorial organ		Natatorial organ.		
Canals	Canals of natatorial organ		Canals of natatorial organ.		
Common cavity	Common tube		Sacculus and common tube	Cavity of stem.	
Canals of branches (*Rhiz.*)					
		Bract		Polype-cell.	
Tentacles, 1.		Thickened edge of stomach		Oval tentacles.	
2.		Prehensile organs		Clavate organs	Tentacles (?).
Generative organs		Generative sac		Generative organ	Generative organ.
		Natatorial organ of generative sac			Natatorial organs (Coryne).
Marginal vesicle		?		?	?

2. "Memoir to accompany a Map of the Magnetic Variation for 1840 in the Atlantic Ocean between the parallels of 60° N. and 60° S. latitude, being Contributions to Terrestrial Magnetism, No. 9." By Lieut.-Colonel Edward Sabine, R.A., For. Sec.R.S., and printed in the Philosophical Transactions.

In this Number of the Magnetic Contributions the author gives maps of the Magnetic Declination in the Atlantic in January 1840, between the parallels of 60° N. and 60° S. lat., founded on 1480 de-